A TASK ORIENTED FEEDBACK MODIFICATION
OF THE FORCE FIELD MODEL *

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ABSTRACT

A model of human behavior is first presented based upon the force field analysis of Lewin. This model includes feedback forces and represents the entire system rather than isolated parts. The model is constructed with weights and input forces; these are combined to produce output forces which are fed back to other components. A questionnaire is used to gather the input for the model, and the results of limited tests with the model as a diagnostic and pedagogical device are described. The two stages of this training concentrate on employing the model as a tool to help participants determine and alter the complex psychological forces operating in such social systems.
INTRODUCTION

The purpose of this study is to describe some of the organizational problems encountered in large projects involving and dependent upon many participants. Examples include curriculum planning, computer systems design, defense projects, etc. A model of the complex social processes developed during the design of such systems is presented. The purpose of the model is to explain some of the actions of the individuals and groups involved in the task. Any such project faces a number of non-technical difficulties which can be classified as organizational problems. Some of these are the product of the individual and his perceptions of his environment while others are created from interactions among those who must cooperate on the project.
Source. A feedback model which describes the pressures involved in a complex social system has been formulated. It is intended to extend the tools available to the change agent trying to analyze a social system. One such device which has been used with success for diagnostic purposes has been a force field analysis. This technique assumes that an individual is constantly under pressure from a number of forces on any one issue. The individual resolves these forces and is in a state of quasi-stationary equilibrium; this equilibrium is quasi-stationary because a shift in the forces can alter the level of performance. Figure I demonstrates the process:

Changes. The purpose of this diagnostic tool is to help clarify some of the forces acting in a complex social system and examine change.

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Lewin describes three steps involved in change: unfreezing, moving, and freezing at a new level. It may be necessary to unfreeze the present level in an individual first before movement to a new level is possible. After the new level has been reached, it is necessary to refreeze or the change will just be temporary.\(^2\) Changes in the equilibrium can be brought about by increasing the driving forces or decreasing the restraining forces. However, a system such as this is under tension, and it is predicted that a reduction in the restraining forces will produce less tension than an increase in the driving forces. The by-products of high tension are aggression and withdrawal, and these can manifest themselves in several ways. Some tension may be good in providing motivation to maintain the level, but it usually happens that increasing only the driving forces increases tension to the point where it is not beneficial. Haire indicates that it is useful to think of the forces as extending over the whole field and varying in strength depending on the distance from the balance point. He suggests that the forces vary as they deviate from the level according to gradients possessing different slopes.\(^3\) Consultants such as Richard Beckhard have indicated success in using this simple diagram to clarify their understanding of the factors influencing complex social systems.

**Shortcomings.** This model is useful, but it has limitations. The physical design of the force field is not conducive to demonstrating the interrelationships between the individuals involved. The force field is

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\(^3\) Mason Haire, *op. cit.*, pp. 169-171.
always in a state of flux according to Lewin, and new equilibria are continually appearing. However, the force field completed for each part of a complex social system tends to show only individual components. It does not clearly demonstrate how the effect in a change in one force acting on an individual influences a second person through a feedback force from the first. Some method is needed which helps to analyze the forces acting on the composite social system and which emphasizes the interrelationships among the various components in the system. The simple force field model can be expanded to be of more assistance to the diagnostician.

ALTERNATIVE MODEL

*Feedback. Figure II shows a social system with two components: individuals and entities.* The arrows represent inputs and feedback paths; each line is either an input or an output. The former are indicated by a subscripted I, and the latter by a subscripted 0. Inputs can be any type of force such as special knowledge, friendships, distrust, etc. The output is referred to as production and includes factors such as encouragement, confusion, leadership, physical goods, etc. In other words, the inputs and outputs are psychological forces, cues to others, or even physical products. The inputs are all known, and the outputs are derived from the processing done by the components. In control theory, the "black box" which is represented by a rectangle in the illustration has a "transfer function" which converts given inputs to outputs. In Figure II, component A is acted upon by an original input

*For the purpose of this model, an entity is a collection of individuals who can be treated as having a single set of inputs, outputs, and a single processing function.*

-5-
I₁ and by the feedback from B, O₂. A transfer function as yet unknown combines I₁ and O₂ to produce output O₁. Component B has a unique input I₂ and is influenced by O₁ from component A. These two forces are combined by B to produce O₂ and O₃; the former is fed back to A and the latter is representative of physical output in the form of work.

**Processing.** One drawback with the force field analysis is that it deemphasizes the part played by the individual subjected to the forces. This person has some reaction (even a lack of response is a reaction) and applies some kind of processing to the inputs. This determines an output which contributes to the force field equilibrium. The model can be adapted to the feedback control diagram if the inputs to this latter model are taken as the forces in the force field. Each component processes the forces which are unique to it; in addition, each component is acted upon by the feedback from other components in the system. The reaction of the individual is substituted for the transfer function and can be thought of as a combination of perception and motivation.

**Performance.** It seems reasonable to assume that an individual will produce an output according to some function that depends on 1) his
own cognitions and 2) the perceived importance of the input. Vroom has developed a model along these lines in which performance (output in this case) is a multiplicative relationship between valence and expectancy. A valence expresses an inclination toward a task or goal. A positive valence exists if the individual favors the task, a negative valence means he wishes to avoid the task, and zero valence implies indifference. Expectancies are the perceived beliefs that a contemplated outcome will occur if certain tasks are completed. The total performance of a job, then, is the sum of all the valences multiplied by the associated expectancies that the given tasks will produce the desired results. The feedback model described here hypothesizes that an output is produced by weighting each input force as positive or negative and summing.

Weights. Each individual is assumed to have a processing function for each output. The inputs are multiplied by weights unique to the individual; each output is produced by a separate set of weights acting on the inputs. These weights are a function of the individual's personality and include his motivation, perceptions, and the value he attaches to each of these forces. The model does not necessarily deal with all dimensions of personality: the methodology emphasizes perceptions. The sum over all the forces, multiplied by the weights associated with each of the inputs produces each output.

\[
O_j = \sum_{i=1}^{m} W_{ij} I_i \quad \text{for } J = 1 \ldots n \text{ outputs}
\]

and \[ W_{ij} = f(V_{ij} E_{ij}) \]

so \[
O_j = \sum_{i=1}^{m} f(V_{ij} E_{ij}) I_i \quad \text{and } i = 1 \ldots m \text{ inputs}
\]

\[ W = \text{weight} \]
\[ V = \text{valence} \]
\[ E = \text{expectancy} \]
\[ O = \text{output} \]
\[ I = \text{input} \]

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5 Ibid, P. 284.
This means that each output \( j \) is produced from some combination of the inputs \( i \) weighted appropriately. The \( W \)'s are determined by the perceptions of the individual combined with motivation. Therefore, it is hypothesized that \( W \) is some unknown, but theoretically measurable, function of valence and expectancy for each \( i \) \( j \). In other words, how an individual weights each input to produce a given output is determined by some function of his expectancy about the given output and his belief about (valence toward) the importance of the input in producing that output. The argument can be reversed for goal avoidance; that is, negative weights, valences, and expectancies are assumed to be operating. Thus, this system of weights is positive or negative, corresponding to whether the force being multiplied is a driving or restraining force for that individual. The output either adds to the total productivity of the system, or is fed back into other components. For component A from Figure II:

\[
W^A_1 I_1 + W^A_2 O_2 = O_1
\]

where \( I \) is an input, \( O \) is output, and \( W \) is a weight unique to each individual for each input. For component B:

\[
W^B_1 I_2 + W^B_2 O_1 = O_2
\]

and

\[
W^B_3 I_2 + W^B_4 O_1 = O_3.
\]

The constraints on \( W \) are

1) \(-1 \leq W \leq 1\)

and

2) for each equation \( \sum_{I=n}^{m} |W_I| = 1 \).

This means that the weights can be either positive or negative for an individual representing a driving (positive) or restraining (negative) force. Finally, the sum of the absolute values of the weights must be unity.
Matrix Representation. From the above it is obvious that if the forces entering the components and those leaving are treated as row vectors, and the processing weights taken as a matrix, standard matrix multiplication produces the desired equations. This is shown in Figure III.

\[
\begin{bmatrix}
I_1 & 0_2 \\
\end{bmatrix}
\begin{bmatrix}
W^A_1 \\
W^A_2 \\
\end{bmatrix}
= 0_1
\]
which gives: \(W^A_1 I_1 + W^A_2 0_2 = 0_1\)

\[
\begin{bmatrix}
I_2 & 0_1 \\
\end{bmatrix}
\begin{bmatrix}
W^B_1 & W^B_3 \\
W^B_2 & W^B_4 \\
\end{bmatrix}
= \begin{bmatrix}
0_2 \\
0_3 \\
\end{bmatrix}
\]
which gives: \(W^B_1 I_2 + W^B_2 0_1 = 0_2\)

and \(W^B_3 I_2 + W^B_4 0_1 = 0_3\)

MATRIX REPRESENTATION

FIGURE III

Solution of System. If the vector of weights can be determined, the system can be solved if the inputs are known. This is true because all inputs are known, and all outputs are described by a single equation which is derived from each input. Thus, there are as many equations as unknowns, and a unique solution can be found from the theory of simultaneous linear equations. Of course, such equations may be inconsistent (parallel graphs) or redundant (identical graphs). However, this is only a theoretical limitation.
Example. As an example, in Figure II let $I_1$ and $I_2$ be Management concern with budgets and rewards for risk taking, respectively. (See Figure IV.) A is a manager, and B is his assistant; A produces an output $O_1$ which says that control over the budget is important. This may be in the form of direct confrontation, memoranda, or subtle reminders. B, the assistant, produces an output $O_2$ which says "ignoring the budget, I can make a higher profit by following Plan X". He can provide this feedback in the form of direct contact, endorsement of Plan X, or occasional hints about the restrictiveness of the budget. How will A respond? Inside the box that is labeled A, some function of A's personality will dictate how much strength the input force $I_1$ has; the strength of $O_2$ will depend on the strength provided by B. The manager will produce his output stressing budgetary control as a combination of $I_1$ and $O_2$. His individual perceptions will determine how much weight is given to the force relating management's concern with budgets and how much to the feedback from A concerning his plan which ignores the budget. The same procedure holds for B. He can tell how strong the force about risk taking is, and some facet of his personality will determine how he weights it and the output from his superior to produce his output, $O_3$.
Implications. It is hypothesized, based upon the earlier force field model, that the greater the number of forces acting with negative weights multiplied by their appropriate weighting vector, the greater the tension in the system. The proposed model can be used to determine what forces influence the given social system; Figure V shows two alternative processing functions and how they affect the final output. In Part A of Figure V, the output $o_1$ is 3.28 units; changing the processing function for component A by introducing a restraining force lowers the output to 1.18 (Part B of Figure V). Corresponding changes are observed throughout the model. By varying the weights and input forces, the maximum effectiveness in reducing tension or changing outputs can be achieved. Of course, this is only possible if some way can be found to measure these weights.

\[
\begin{align*}
\begin{bmatrix} 1 & 4 \end{bmatrix} & \begin{bmatrix} .5 \\ .5 \end{bmatrix} = \begin{bmatrix} .5 \\ .5 \end{bmatrix} \\
2.5 & 2.5 \\
\end{align*}
\]

\[
\begin{align*}
\begin{bmatrix} 4 & \phi_2 \end{bmatrix} & \begin{bmatrix} .5 \\ .5 \end{bmatrix} = \phi_1 \\
\phi_2 & 2.5 \\
\end{align*}
\]

\[
\begin{align*}
\begin{bmatrix} 2 & \phi_1 \end{bmatrix} & \begin{bmatrix} .6 & .3 \\ .4 & .7 \end{bmatrix} = \begin{bmatrix} \phi_2 & \phi_3 \end{bmatrix} \\
\phi_2 & 2.875 \\
\end{align*}
\]

\[
\begin{align*}
2 + 0.5\phi_2 &= \phi_1 \\
1.2 + 0.4\phi_1 &= \phi_2 \\
0.6 + 0.7\phi_1 &= \phi_3 \\
\phi_1 &= 3.25 \\
\phi_2 &= 2.5 \\
\phi_3 &= 2.875
\end{align*}
\]
\[ \begin{bmatrix} 4 & \varnothing_2 \\ \varnothing_1 & -0.5 \end{bmatrix} \begin{bmatrix} 0.5 \\ -0.5 \end{bmatrix} = \varnothing_1 \]

\[ \begin{bmatrix} 2 & \varnothing_1 \\ \varnothing_2 & 0.6 & 0.3 \\ 0.4 & 0.7 \end{bmatrix} = \begin{bmatrix} \varnothing_2 \\ \varnothing_3 \end{bmatrix} \]

\[ 2 - 0.5 \varnothing_2 = \varnothing_1 \]
\[ 1.2 + 0.4 \varnothing_1 = \varnothing_2 \]
\[ 0.6 + 0.7 \varnothing_1 = \varnothing_3 \]

**FEEDBACK SOLUTION**

**FIGURE V-B**

*Change.* Two types of change are recognized in this model. The strength of an original force can be altered either by the individual in the case of an original force, or by some overall change in the system in the case of feedback forces. In addition, the weights are dynamic over a period of time. An individual can change the emphasis he places on each given input to produce each output. This type of change is one of attitude or cognition, and the model makes no attempt to explain the actual mechanism. Instead, it attempts to measure the change and predict how it will effect
the rest of the social system. Considering Lewin's comments on the three steps of change, the lack of a permanent refreezing will be shown by a series of weights and forces which, although changing, tend to return to one particular level. That is, changes which show no consistent movement in one direction or another will be indicative of a transient change: the vascillation of the force or weights will provide evidence that change has not been stabilized.

**Measurement.** The measurement of these forces can be accomplished using questionnaires with a scale of discrimination. Individuals are asked to rate how the various forces influence them on a scale of 0 to 10. The strength of these forces is also rated on a scale from 1 to 10. These original forces may have been delineated by an observer, or through a mutual problem solving session in which all parties work on identifying the forces present. Thomas has experimented with having the participants directly list the forces they feel are acting on them. This method is rejected here because of his comments concerning the realism of these forces. (Reality here must be taken as a majority analysis of the forces performed by outsiders and those within the system.) Thomas reports that many of the managers saw driving forces while an outside observer could only discern restraining forces. For this reason, the method of either a mutual session or the use of an outsider to diagnose the system is suggested.

**Testing.** A model such as the one presented here is very difficult to validate statistically. Two methods can be used, but both of these have undesirable aspects. First, a questionnaire can be given at two different points in time. The original forces can be entered into the model and solved, and the feedback forces compared. The group is asked also to rate the feedback
forces and these data are compared with the predicted changes in the feedback forces from the model. A second approach is to take a reading of the forces at only one point in time and vary the forces and weights to see the effect in the outputs. This requires comparison with a trained group who has predicted how the feedback forces will move given changes in the inputs. Both of these methods rely on the ratings of either the participants or a trained panel of outsiders to determine how the forces did or can be expected to change. However, there is no guarantee that this control group is any more skillful in prediction than the model itself. Because in the first approach the people actually involved rate the feedback forces along with the original forces, it is the most desirable approach.

Reality. The attempt to place numerical quantities on such a model of social processes may appear unnecessary because the variables are so hard to measure accurately. However, the purpose here differs from the typical operations research or engineering model. The figures can be far more approximate because the measuring devices are much cruder. The object is to aid the consultant in diagnosis and in identifying the forces which should receive the most priority. The most important aspect of the measurement is the degree of congruence of perceptions and the analysis of extreme differences which inhibit collaboration. It must be remembered that each of these forces is constantly changing over time, and that such a feedback diagram and associated solutions can only represent a picture in one time frame. By changing the various inputs, the most pressing forces can be isolated and attention given to the most important. It is essential to recognize that the model cannot show forces which may disappear in time. It is unable to predict changes in the individual's motivational weights that combine the inputs to produce outputs.
Case Study. The model was tested with data from a computer system design project. Unfortunately, due to the political situation, only three people could be involved in filling out the questionnaires. This, of course, is insufficient to statistically validate the model, but it did lead to the training program suggested in the next section. Figure V presents a block diagram of the complete system; the forces are numbered, but not identified as the particular case must remain anonymous. The diagram is included to show the complexity which may be included in an application of the model. A series of three tests was conducted using data developed from the questionnaire. (The questionnaire was quite open ended since time and distance did not allow for its joint development.) The first test attempted to predict the changes in conditions between two periods in time. Unfortunately, the data was only taken at one point, and the results are therefore suspect. The model only predicted about 40% of the changes correctly. (Here, correctly had to be taken as the majority opinion of several involved in the project.) A second test in which one of the forces was altered showed changes in the other forces which were reasonable. A third test changing one of the weights showed the same expected results. Of course, this is not a valid experiment since the number of participants was small both in filling out the questionnaire on the forces and in predicting the expected changes in forces.
Questionnaire Data. The data used in the experiments provides much interesting information about how the three respondents viewed the system. For the most part, the replies were close, however, there were several cases in which the answers were exact opposites which may be explained by a lack of understanding or different interpretation of the question. The accuracy was made less certain because the questionnaires were not administered in person, but were completed through the mail. The most interesting results are those differing in degree. For example, one individual saw one of his forces as contributing less to the performance of another entity, while others attached more significance to this force.

Deficiencies. Several reasons were given above to question the results due to the experimental methods. However, there are limitations to the model, itself. It is quite possible that there are forces operating which the model simply does not consider. These can be in the form of forces that are too threatening to be brought into the open, or forces which seem minor to the individual but really are very important subconsciously. The normalization of the processing weights may also tend to hide undercurrents, and the linear assumptions of the model may not be justified. The method of weighting the forces may be inadequate to explain the complexity of the situation. It is possible that dynamics beyond the predictive powers of the model are operating. It may be that the forces are varying too rapidly to employ the model; it assumes that for some short period of time, say a week, the forces remain steady and can be used in the evaluation. The model assumes that between any readings of input, the forces settle down and transients die out when, in reality, the transient
effects may be considerable and quite important. One area of future investigation is the use of differential rather than linear equations in the model.

**USE OF MODEL**

**Force Field.** When the force field model was first discussed, one advantage proposed was the speed with which it can be used. Such a simple mechanism can be used to delineate the forces acting on an individual without any formal preparation. Thomas has expanded the force field and used it to help individuals become aware of the forces surrounding them. The same type of approach can be accomplished with the feedback model.

**Feedback Model.** The primary reason for modifying the force field is to show the feedback from one component to another. Without bothering with questionnaires, matrices, or any numbers at all, a very quick reading of a situation can be taken with the feedback model. Its main advantage is to show how a force that is fed back propagates itself throughout the whole system and stimulates other responses. This feedback model was first developed after a basic analysis of a case was attempted using the force field; it was found to be inadequate considering the complexities of the system. The model has also been used in this form in another situation, and was found to be a very valuable tool for showing interrelationships which might have been otherwise ignored.
Difficulty. If, from the limited testing of the mathematical part of the model that has been undertaken so far, some predictive ability can be attributed to the calculations; then the question becomes will the model provide enough information to make the effort worthwhile? First, a program can be written to handle all of the routine work of processing the questionnaires and producing the equation matrix. If this is done, all that is necessary is to key punch the responses. This has the added value of producing data for other statistical tests on the responses. For example, other tests can show the significance of the variability in the responses to the questionnaire. Various forces can also be grouped and a factor analysis performed to explore relationships among forces. However, that still leaves the preparation of questionnaires; this may be the by-product of the training undertaken for such a project.

TRAINING PROGRAM

Learning Assumptions. The training exercises suggested below are based upon certain learning assumptions and the belief that the model can provide experiences congruent with these assumptions. People involved in change efforts need adequate data, and this data must be received in a non-threatening manner. It is also important that information be fed back quickly while it is still timely, and that others involved be present to explore and test the data. In the case of a task oriented group, the training will be perceived as more valuable by the participants if it is focused on the job which is being undertaken. The feedback model used in the suggested training program helps to meet these objectives.
**Stage One.** A two stage program of training is recommended for any large-scale project. The first stage of the training is to gather various appropriate subsets of those involved in the project together. The change agent can explain some of the forces acting on him and suggest various forces that may be present in the group. Hopefully, this will be enough of a stimulus for others to begin, and the questionnaire will be developed from the responses. These stage one meetings are not predictive: they are intended to ask what problems and forces exist right now in the system. Stage two then works on these problems and perceptions. This implies that stage one meetings should be held during the course of the project to develop new forces which may have arisen since the last series of meetings.

**Stage Two.** In the second stage the various outputs can be discussed to see what forces are the most important. The responses to the questionnaire can be used as a starting place for discussing perceptual differences. The emphasis on influential forces is one fundamental benefit of the feedback model. It requires the various participants to observe how pervasive certain forces are in determining their behavior, and it shows how some of the cues they provide affect others. Once such a series of first and second stage meetings has been held and various forces explained, some of them can be altered through awareness and by special second stage sessions including just those who are most concerned with that force or relationship. The model can be used with or without mathematics to help determine which forces are the most important. The exercises with the model help to provide a less threatening training session than a T-group. The problems are oriented around a framework which is more objective and less intensely interpersonal than certain forms of training. The model helps to rationalize data about irrational feelings which makes it legitimate to discuss and admit ownership of these feelings.
Continuing Effort. It is hoped that both first and second stage meetings will be held during the course of the project to help keep communications intact as various forces change. Frequent stage one meetings will assist in alleviating one of the deficiencies of the model. First, continued meetings will help to insure that changes in the forces and the development of new forces are considered. Secondly, continued practice in the searching for and analysis of forces may result in the revelation of some of the more deeply hidden forces. Stage one can best be called a searching or discovery process, and stage two is working the problems developed from the first exercises. This does consume time, but it is felt that the results will more than repay the time used in training. The products should be increased efficiency on the task and less tension in the entire system.

Confrontation Techniques. Two recent articles by Beckhard, and Golembiewski and Blumberg discuss non-T-group oriented training efforts. Beckhard refers to a "confrontation meeting" which is used to free feelings and produce feedback in a relatively short time. The characteristics of this meeting are open communications, processing of current data, the development of dialogue, the involvement of large numbers of people, ownership of feelings, collaborative goal setting, increased trust, and the experience of success. The feedback model is a parallel technique sharing many of the same goals. It is dedicated to freeing communications, processing current data, the


ownership of perceptions, collaborative goal definition, and increased trust through shared perceptions. Golembiewski and Blumberg present a study in which a public sharing of "Images" freed members through confrontation. Statistically significant attitude changes did occur as a result of the exercises. These images are analogous to the perceptions in the feedback model. While this experiment was a portion of a longer training project, the goals appear to correspond well to those of the feedback model. Participants selected relevant others, while in the feedback model, the task also helps determine who is relevant. Golembiewski and Blumberg conclude that the confrontation requires less skilled participants and that a non-T-group technique can generate much learning. These findings support the feedback model and suggest ways in which it can be employed.

SUMMARY

An abstract model of human behavior is first presented based upon the force field analysis of Lewin. The essential parts of this model are the feedback forces and the technique of representing the entire system rather than just isolated parts. The model assumes that a series of input forces are processed in some unique way by each individual to produce each given output force. The processing is represented by a series of weights which combine the various inputs and produce each result. These weights and forces can be measured through questionnaires and/or observation. The model was used on an actual project. However, due to the limited scope of the experiments, they were inconclusive. It is suggested that more work be done to validate the mathematical theory. However, this does not diminish the value of the model as a practical training tool.
The main advantages suggested for this approach are:

1. The model shows interrelations and how forces are perpetuated throughout a social system.

2. As a training tool, it can be used to bring some of these forces into the open and to work on modifying them; it helps to rationalize data about irrational feelings.

3. The use of this model creates an awareness on the part of the participants of how important a single force can be in their behavior. It also is a reminder that each action is influenced by all of the various forces acting on the individual.

4. Though not completely substantiated yet, the model does offer the potential of having predictive abilities.

A continuing training program is suggested employing the model as a practical and pedagogical device. Stage one emphasizes the discovery of forces and stage two concentrates on working with the model and the forces.

Further research can be conducted on the mathematical portions of the proposed model. In addition, the questionnaires have not been completely explored for potential information. It is suggested that the forces may be grouped together by type, such as those relating to maintenance of relationships, the production of output, etc. Such a categorization may provide a better understanding of how individuals function in such a project, and how friction can be reduced.

It is hoped that the suggested methods can be employed in a wide range of situations to help analyze and deal with forces which develop within a task-oriented group.


